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ACKNOWLEDGEMENTS

This publication was originally prepared by Barry Bannatyne, and has been expanded and revised by Richard Gunter, with the assistance of many of the staff at Manitoba Energy and Mines.

"Loading facilities at the Amaranth Quarry"

Message From The Minister Of Energy And Mines

Manitoba's abundant mineral deposits form a vital part of our province's rich natural resource heritage. It is almost impossible to spend even a day in our province without using some item which contains a tiny part of this heritage. Your home or workplace, no doubt, has concrete which includes our abundant sand and gravel. Or perhaps it uses building stone from one of Manitoba's quarries. Somewhere in your home there is likely to be copper pipe or wire which may well have originated from a northern Manitoba mine. The same mines produce the zinc which is used to galvanize much of the metal in your car. You may sit down to dinner with stainless steel cutlery which requires nickel – one of Manitoba's richest mineral resources. Your car may use gasoline refined from Manitoba oil. You may even use Manitoba's gold when you exchange rings on your wedding day.

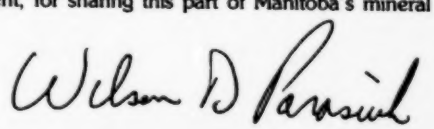
In getting these resources out of the ground and into your life, Manitoba's mining, quarrying and petroleum industries create thousands of jobs for Manitobans, including everything from clerks to miners to executives. These people, in turn, spend their salaries on goods and services which provide the lifeblood for countless more employees and businesses. In total, these industries and their spin-off benefits make a major contribution to Manitoba's prosperity and stability.

These resources also provide a significant source of income for the provincial government. Royalties and taxes ensure that revenues from our natural resource heritage contribute to maintaining the level of services Manitobans expect. These revenues help pay for the quality schools, hospitals, and roads which make Manitoba a fine place to live.

In the Mineral Education Series, we hope to increase Manitobans' awareness of the wealth and variety of our mineral resources and their importance. Each booklet in the series explains one aspect of our mineral industry, describing the mineral resource, the history of its development in Manitoba and the industry today. We hope the series will convey some of the importance and excitement of exploiting Manitoba's mineral resource heritage.

Gypsum in Manitoba examines a mineral resource with a history in the province which goes back to 1901. Despite a modest profile, Manitoba's gypsum mines provide the feedstock for two wallboard plants and two cement plants in Winnipeg, as well as exports to Saskatchewan wallboard and cement producers. With immense reserves and established markets, gypsum mining should continue to play an important role in Manitoba's industrial mineral industry.

In **Gypsum in Manitoba** Richard Gunter, a geologist with Manitoba Energy and Mines, details the history and current nature of this little known part of Manitoba's mineral heritage. I would like to thank him, and all of the staff of our Department, for sharing this part of Manitoba's mineral resource story.



Wilson Parasiuk
Minister
Energy & Mines

Gypsum

In sharp contrast to today, 175 million years ago Manitoba was an area of warm seas with a warm, dry climate. It was during this period, known as the Jurassic Age, that Manitoba's gypsum deposits were created. As the warm sea water evaporated, it left behind beds of evaporite minerals.

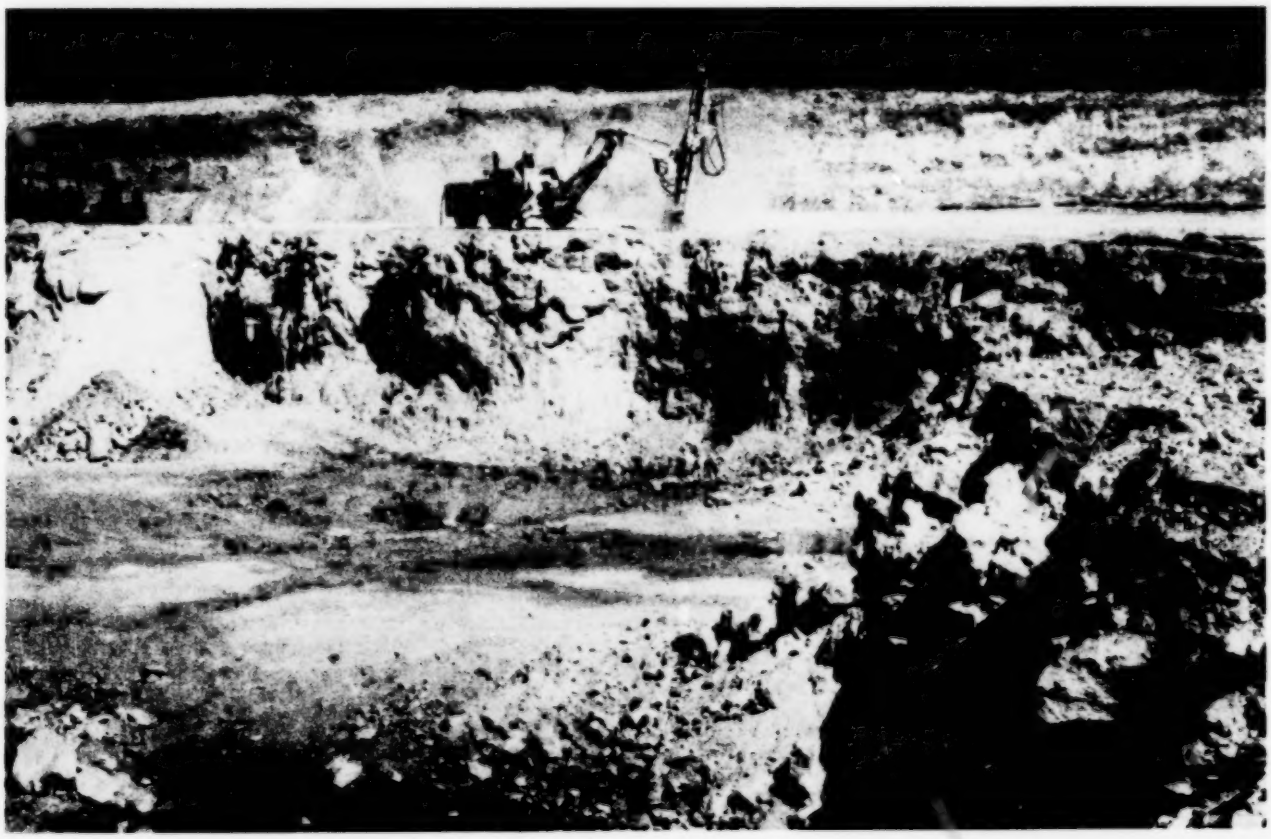
Calcium (Ca^{+2}) and sulphate (SO_4^{-2}) ions are a normal part of sea water. When water evaporation in a warm and dry climate increases their concentration past a certain point, the ions combine to form gypsum ($CaSO_4 \cdot 2H_20$), and anhydrite ($CaSO_4$). In Manitoba this process led to deposits of gypsum and anhydrite in a layer 8 to 38 metres thick. In geological terms these beds form part of the Amaranth Formation.

Natural deposits seldom contain 100% of these minerals. In Manitoba the deposits contain from four to 20 per cent dolomite and one to five per cent clay. These impurities occur either intermixed with the gypsum and anhydrite, or as thin layers interbedded with them. While anhydrite is not used commercially by itself, some commercial applications for gypsum can tolerate up to 15% anhydrite content. As well, when it is close to the surface, reaction with circulating water will gradually convert anhydrite to gypsum.

Ideal Chemical Compositions for Gypsum and Anhydrite

	Gypsum	**Anhydrite**
Ca0 (lime)	32.6%	41.2%
$S0_3$ (sulphur trioxide)	46.5	58.8
H_20 (combined water)	20.9	0
Total:	100.0	100.0

For a more detailed description of the mineralogy of gypsum, and its varieties and classic localities in Manitoba, the reader is referred to another publication of Manitoba Energy and Mines entitled **Minerals of Manitoba, Volume 1: Non-metallic and Pegmatitic.**



"Drilling at the Amaranth Quarry"

Uses

Gypsum is a soft mineral with several uses in the construction industry. It is the primary ingredient in gypsum wallboard and plaster of Paris, and is used as an additive in Portland cement.

In Manitoba, gypsum is used mainly in the manufacture of wallboard for the construction industry. Two plants in Winnipeg, Westroc Industries Limited and Domtar Construction Materials Limited, process the gypsum and fabricate wallboard. The gypsum is first heated, or calcined, to 160°C, releasing three-quarters of its water. The resulting product is mixed with various additives and spread between two sheets of heavy paper, then allowed to dry into the finished wallboard (Figure 1).

While plaster of Paris is not manufactured in Manitoba, primarily because of the small local market for the product, the process is similar. Calcined gypsum is mixed with water, moulded or spread and allowed to set into plaster of Paris.

Manitoba gypsum is used by two Winnipeg cement plants – Canada Cement Lafarge Ltd. and Genstar Cement Ltd. At the cement plants, the raw gypsum is crushed to a fine powder and mixed with pulverized Portland cement to control the setting time of concrete.

In addition to its Manitoba market, gypsum is also shipped to a wallboard plant in Saskatoon and a cement plant in Regina.

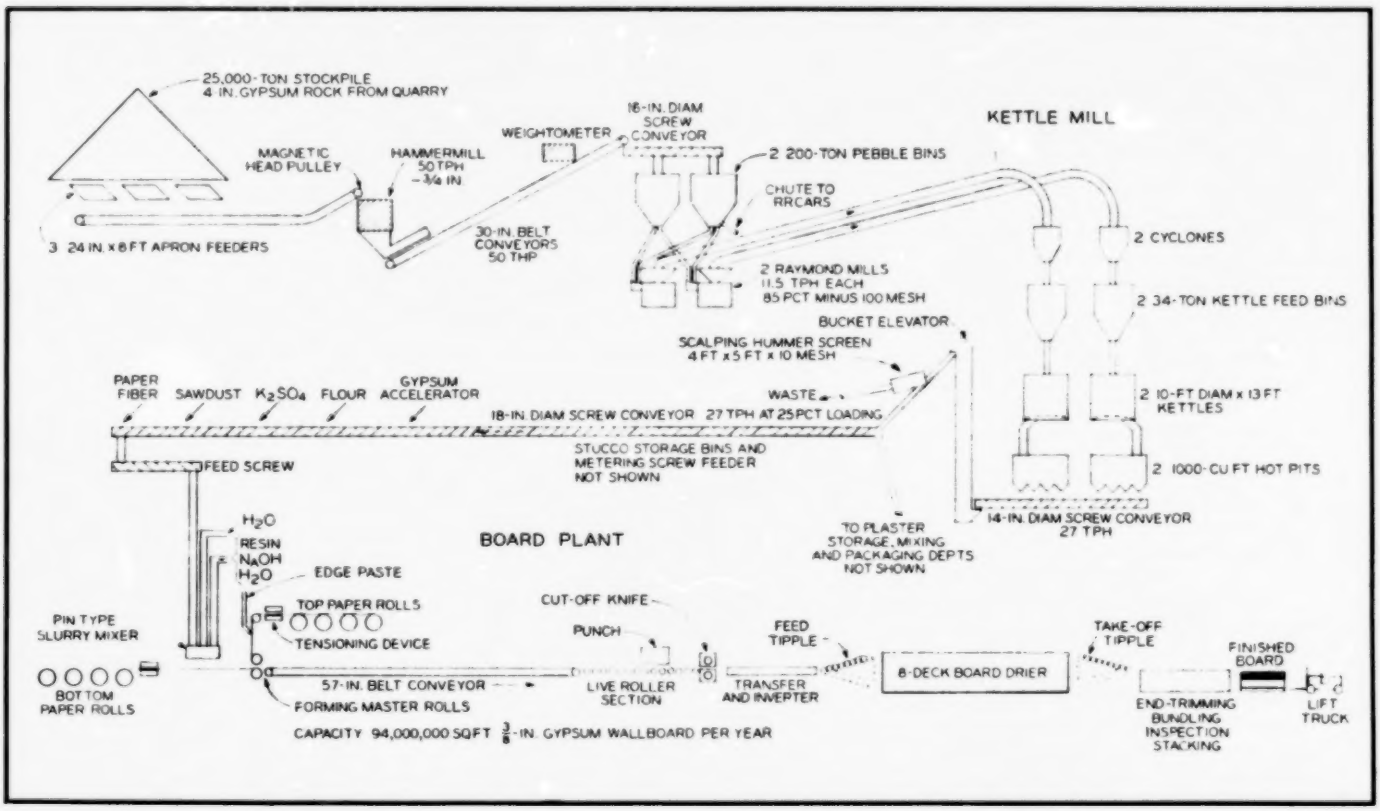


Figure 1:
Simplified flow diagram for a complete small gypsum plant. Acknowledgement: reproduced with permission from "Industrial Minerals and Rocks" 3rd edition (1960).

Gypsum Production In Manitoba

Gypsum has been a part of Manitoba's mining industry since 1901. Before the post-World War II building boom, annual production fluctuated between 610 and 60,960 tonnes. From 1946 to 1959 Manitoba's production increased annually, reaching a peak of 203,200 tonnes. Since then production has stabilized at an average of 172,720 tonnes per year (Figure 2).

Over the years, a number of companies have operated gypsum mines in the province (Table 1). Historically, three areas have provided all of Manitoba's gypsum – Gypsumville, Amaranth, and Silver Plains.

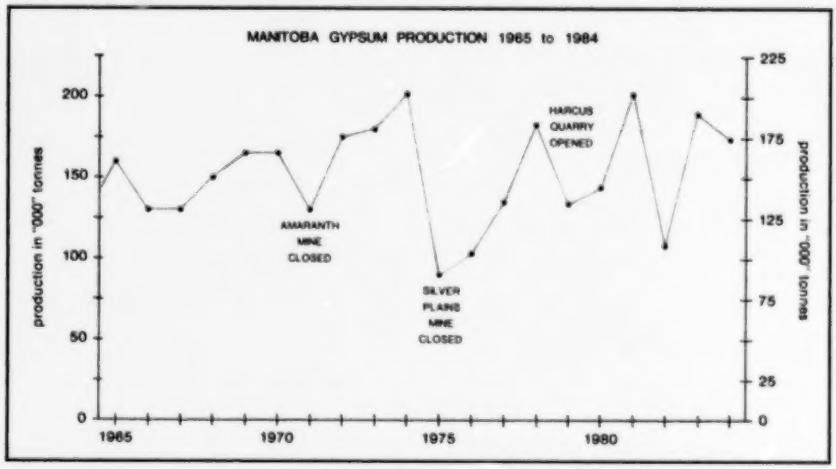


Figure 2: Gypsum production in Manitoba, 1965 to 1984.

Table 1: Gypsum Operations in Manitoba

Gypsumville	Q*	1901-1904	Manitoba Union Mining Company
	Q	1904-1928	Manitoba Gypsum Company
	Q	1928-1959	Gypsum, Lime and Alabastine, Canada, Limited
	Q	1959-1986	Domtar Construction Materials Limited
Amaranth	M*	1929-1963	Western Gypsum Products Limited
	M	1967-1970	B.A.C.M. Industries Limited
	Q	1977-1986	Westroc Industries Limited
Silver Plains	M	1964-1975	Westroc Industries Limited (formerly Western Gypsum Products Limited)

*Q: quarry; *M: underground mine

Gypsumville was the first deposit to be developed and is the only one to operate without major interruptions. The Amaranth deposit was developed in 1929 by Manitoba's first underground gypsum mine, which operated until 1963. A second mine operated from 1967 to 1970. In 1977 the deposit was developed by an open pit mine.

The mine near the Silver Plains deposit was developed as an underground mine, with production in 1964. The Silver Plains mine closed in 1975 due to flooding of the shaft. This meant that in 1976 the only Manitoba production was from the Gypsumville deposit. In 1977 the Amaranth quarry opened and in 1986, the two quarries shared Manitoba gypsum production with 80% from Amaranth and 20% from Gypsumville.

In recent years Manitoba's total gypsum production has ranged between 81,280 and 203,200 tonnes annually. Figure 3 represents Manitoba's contribution to total world production for 1985.

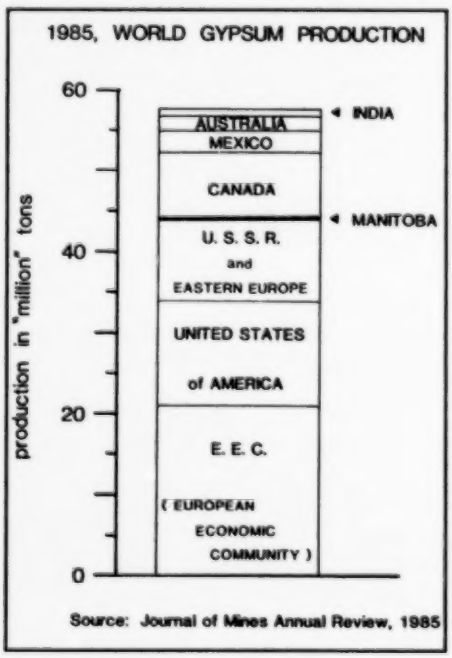


Figure 3:
Manitoba's contribution to the world production of gypsum.

Gypsum Occurrences In Manitoba

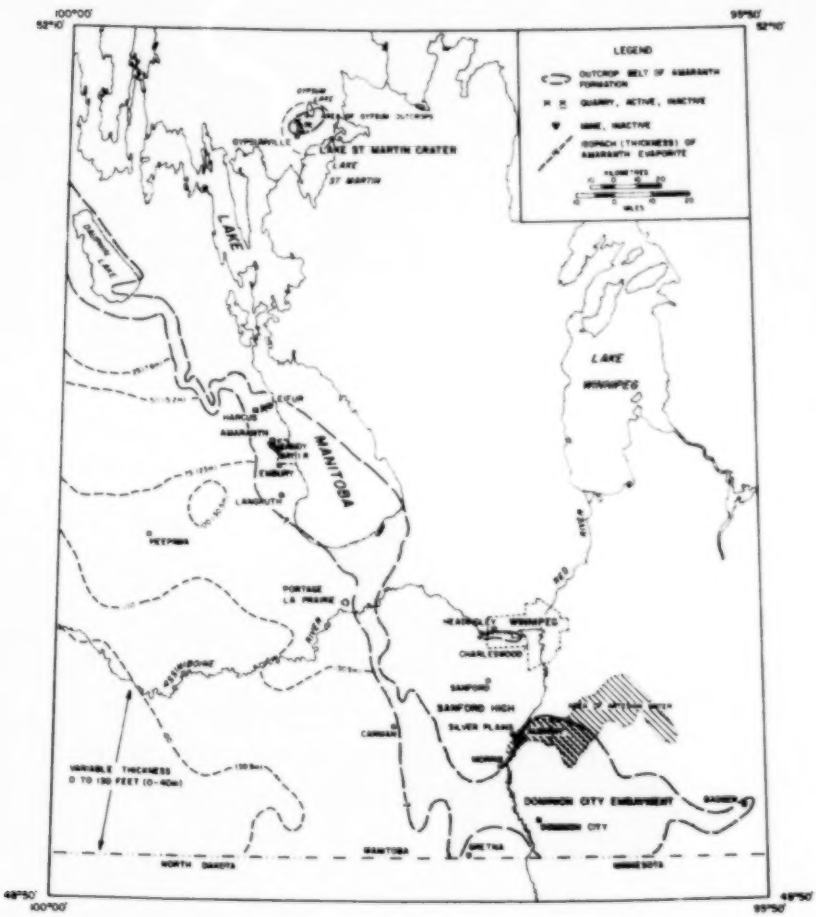


Figure 4:
Gypsum deposits in the Amaranth Formation of Jurassic age in Manitoba.

The Amaranth Formation of the Jurassic age (175 million years ago), where gypsum deposits in Manitoba occur, consists of an upper layer of gypsum and anhydrite and a lower sequence of red shale and sandstone. The gypsum-bearing strata were deposited on the northeastern flank of the Williston Basin – a sedimentary basin centred in western North Dakota which includes much of southwestern Manitoba.

The original northern depositional edge of the formation occurs in the area of Dauphin Lake, with its thickness increasing southward. The original eastward extent is not known but may have been as far east as Lake Winnipeg. Other outcrops of the formation occur within a crater structure at Gypsumville, and in a local channel in the Headingley-Charleswood area. The formation occurs also in a lagoon-like extension of the Williston Basin in an area east of the Red River. This extension was named the Dominion City Embayment in 1964 (Figure 4).

In the outcrop belt extending southeastward from Dauphin Lake to the International Boundary, the gypsum deposits form a more or less continuous layer. Gaps in the outcrop were possibly removed by glaciation during later ice age periods. The Williston Basin is largely well populated and is the home of Manitoba's oil patch. Knowledge of the extent of the gypsum layer has been enriched by the many exploratory oil wells, water wells, and industrial minerals test holes which have intersected it.

Dolomite patches and fragments are scattered through the gypsum and anhydrite, giving the evaporites a mosaic texture. This suggests that the deposit was formed near the shoreline of a shallow inland sea. As an arid climate evaporates the sea water, both gypsum and anhydrite are deposited. As they settle, the minerals displace and fragment the soft lime mud, creating the dolomite intrusions in the gypsum beds. Deposits with a similar texture called "sabkhas", are formed in low-lying areas along the coast of parts of the Persian Gulf.

Figures 5 and 6 show the measured sections through the gypsum layer in Manitoba's operating quarries.

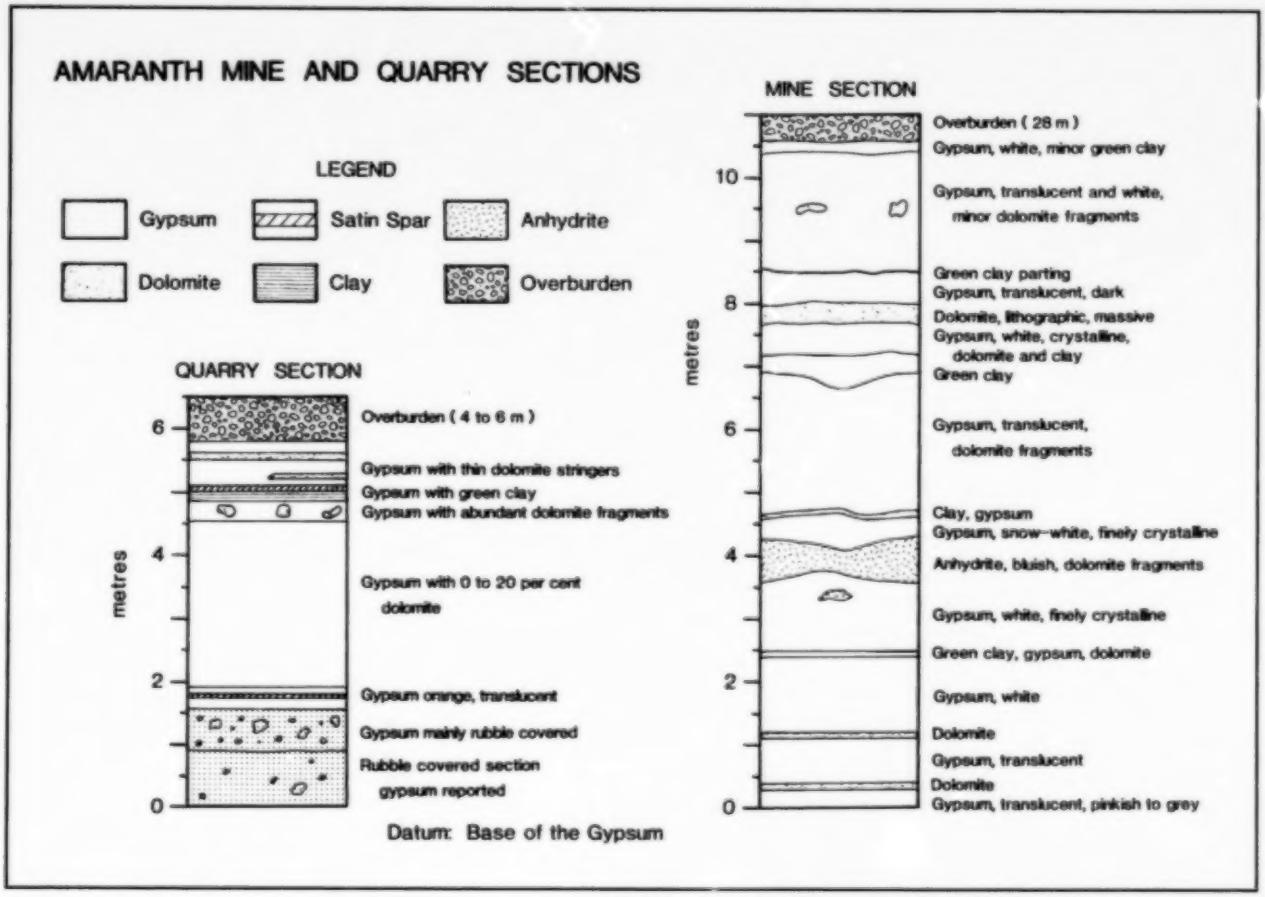


Figure 5:
Amaranth mine and quarry sections.

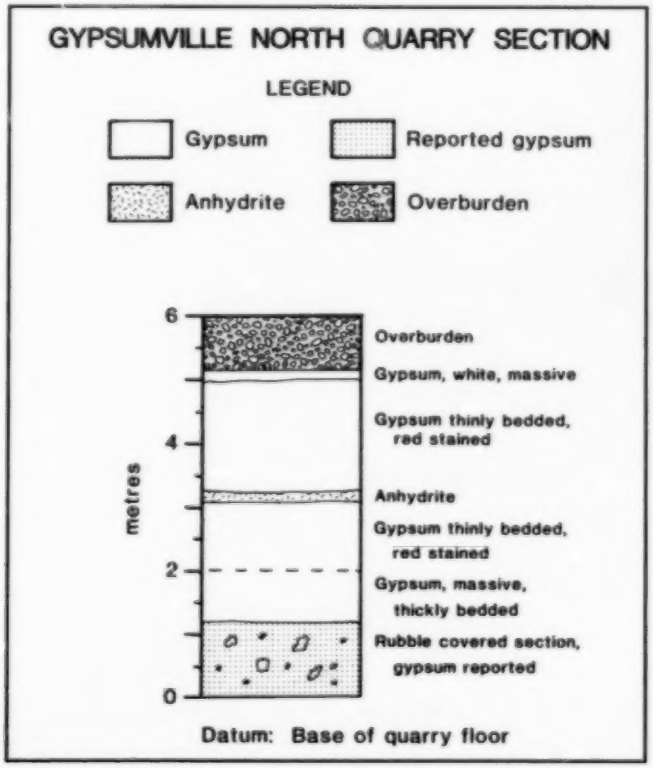


Figure 6:
Gypsumville north quarry section.

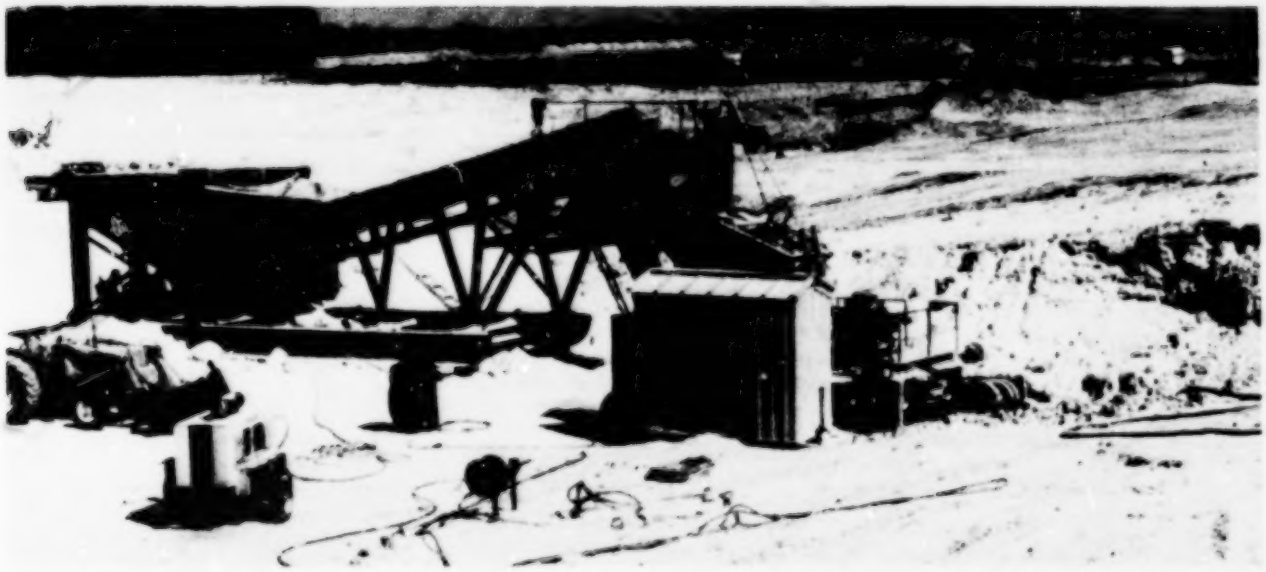


Figure 7:
Amaranth pit and plant site.

Amaranth Quarry

The Amaranth Quarry, 15 kilometres north of the village of Amaranth, is located about 150 kilometres northwest of Winnipeg. The quarry is situated near the northeastern edge of the Jurassic outcrop belt (Figure 4). This surface mining operation, in 1982, consisted of a 5.8 metre section of gypsum lying beneath 5.2 metres of overburden (Figure 7).

L. Zaseybida, a private individual, first investigated this deposit in 1965. A series of 39 drill holes outlined a 12.7 million tonne mineable body of gypsum. No commercial production took place and the leases and permits on the property expired in 1975. In 1977 Westroc Industries obtained a Quarry Mineral Lease on the area, drilled 20 exploration holes, and sank a pit for a bulk test sample of 225 tonnes. Mining began in July 1978, at an initial rate of 101,600 tonnes per year. Production has consistently exceeded that rate in the ensuing years.

Since opening in 1978, the Amaranth quarry has dominated the gypsum industry in Manitoba, accounting for 80% of the province's production. Product from the quarry is trucked to the Westroc wallboard plant and the cement plants in Winnipeg. The Amaranth gypsum is also trucked to a rail terminal, approximately 35 kilometres northwest of Portage la Prairie, where it is loaded for export to the wallboard plant in Saskatoon and the cement plant in Regina.

Gypsumville

The evaporite deposits at Gypsumville are unusual in several respects. They occur as ridges as much as 15 metres higher than the surrounding plains and swamplands that are underlain in places by thick glacial deposits. In many places the gypsum beds have been contorted into folds of several types, including anticlinal, overthrust, and complex interference folds. These contortions are ascribed to ice-thrusting by glaciers after the beds were formed (Figure 8).

The ridge outcrops occur within an area 16 kilometres long and 13 kilometres wide, extending northeastward from Gypsumville to east of Gypsum Lake. This area is entirely within the almost perfectly circular Lake St. Martin impact structure, 23 kilometres in diameter and centred 8 kilometres east-northeast of Gypsumville. This structure was probably formed by meteorite impact and was examined in detail by provincial

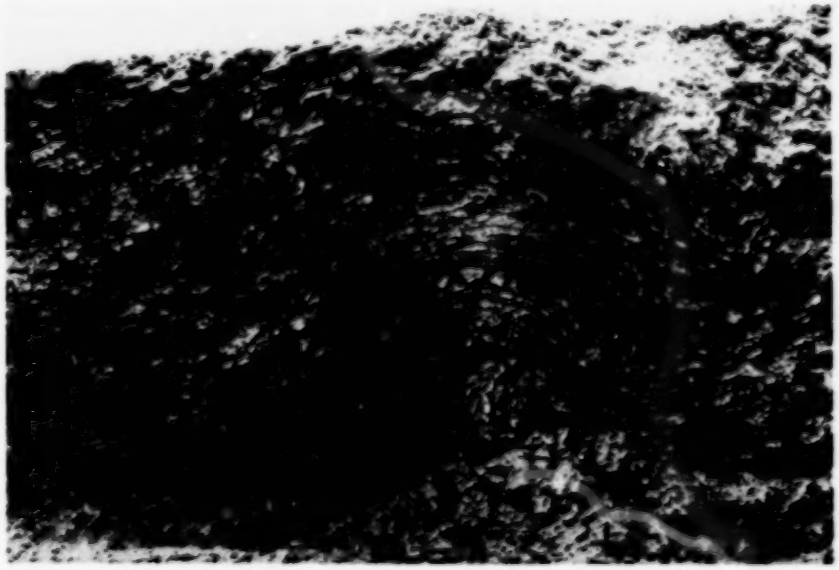


Figure 8:
Portion of the north quarry, Gypsumville.

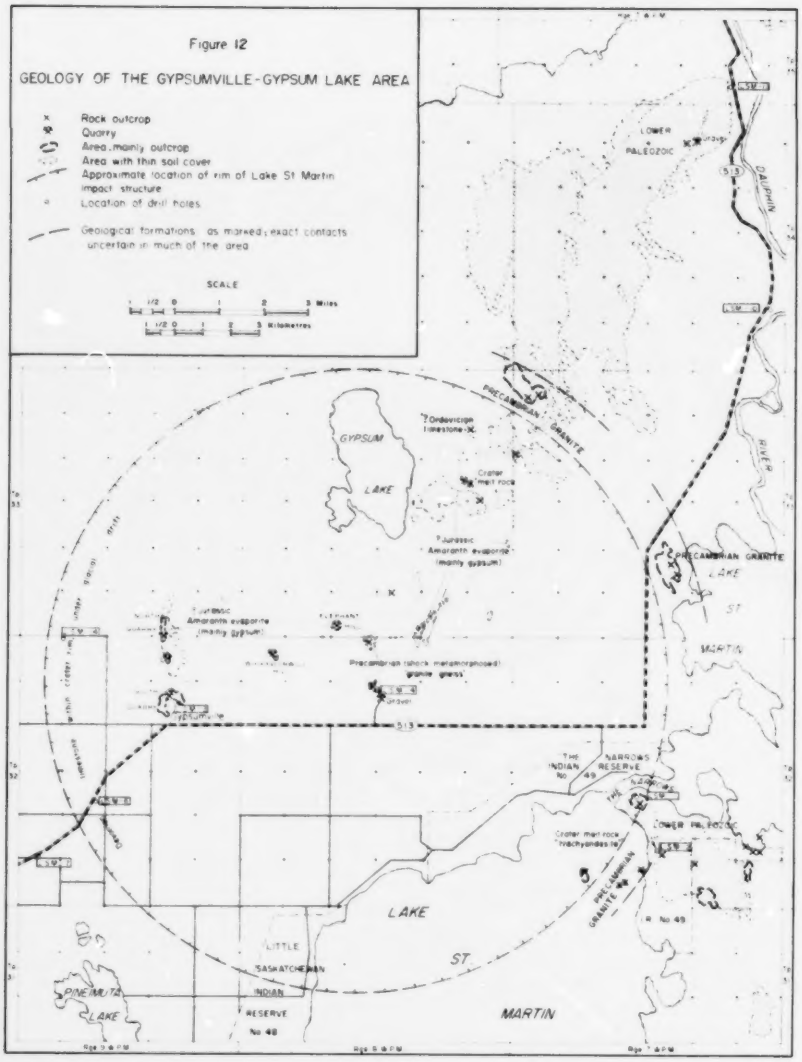


Figure 9:
Geology of the Gypsumville-Gypsum Lake area (McCabe and Bannatyne, 1970).

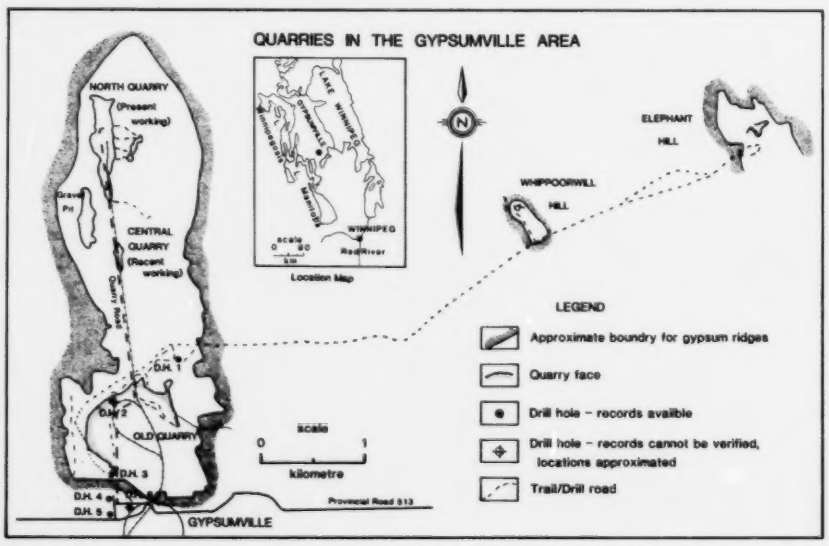


Figure 10:
Quarries in the Gypsumville area (Hoque, 1967).

geologists in 1970. The gypsum deposits are confined to the northern half of the crater.

The rock character changes at Gypsumville. From a bed consisting of 42 metres of predominantly gypsum/anhydrite and 16 metres of red sedimentary rocks, it is transformed within the space of one kilometre, to red beds 53 metres thick. In the southern half of the crater, equivalent deposits, if present, have been eroded, and replaced by thick glacial deposits, probably laid down in a preglacial valley (Figure 9 and 10).

The deposit at Gypsumville consists generally of an upper layer of gypsum in thin beds separated by even thinner layers of grey clay, and a lower, thicker layer of anhydrite. Analyses of samples reported to be less pure than the average ore, indicated a gypsum content of 90.05 to 95.00 per cent, with 3.00 to 7.10 per cent dolomite and 0.75 to 2.90 per cent clay. Thus, the workable part of the deposit is of good quality.

Examination of drill core and of quarry exposures indicates that a sharp change to anhydrite occurs below the floor level of the quarries. This means that gypsum reserves are limited mainly to the ridges. Even with this limitation, reserves of gypsum in the area are considered to be many millions of tonnes, although precise figures are unavailable.

The Elephant Hill deposit, six kilometres east of the main quarries north of Gypsumville, has not been quarried recently because of the difficulty in access. The deposit contains a pure white alabaster which is suitable for carving. Large plates of selenite (a crystalline form of gypsum), as much as 60 centimetres across, also occur in the deposit. Glauberite, a sodium calcium sulphate mineral, occurs in layers a few metres thick within the anhydrite about 27 metres below the floor of the old quarry, one kilometre north of Gypsumville.

Non-Producing Properties

Amaranth-Portage La Prairie Area

The outcrop belt of the Amaranth Formation extends southeastward from Dauphin Lake to Harcus, southward to Amaranth and Langruth, and southeastward to Portage la Prairie (Figure 4). Glacial drift covers the gypsum to a depth of three metres to more than 60 metres.

In the area east of Harcus, exploration drilling in sinkholes has indicated three to nine metres of good quality gypsum is present under three to eight metres of glacial drift. Anhydrite is not present, and clay content is low, but the gypsum layer contains eight to ten per cent dolomite. The possibility exists that more than one quarry could be operated there.

Between 1929 and 1970, gypsum mines operated at two locations just south of Amaranth (Table 1). A section of the mine operated by Western Gypsum Products Limited is illustrated in Figure 5. Nodules or concretions of quartz and chert occur sporadically within the gypsum.

At the Western Gypsum mine, the interval between 29.3 and 39.9 metres was removed using the room and pillar method, with the anhydrite layer left as a layer of broken rock on the floor of the mine. Vertical shafts were used for access. The first shaft sunk by Western Gypsum, before the Amaranth location was chosen, was located near Embury, 13 kilometres southeast of Amaranth. The gypsum was reported to be 7.6 to 10.6 metres thick, under a 12.2 metre layer of glacial drift.

At the B.A.C.M. Limited mine, accessible by a sloped decline, mining was confined to the gypsum above the anhydrite layer, and a section averaging 4.5 metres was removed. A tunnel excavated under Highway 50 allowed access to the part of the deposit west of the highway. The gypsum was crushed underground and taken by conveyor belt to loading bins above a railway spur line.

The Amaranth Formation forms the surface of the bedrock north and east of Portage la Prairie. The glacial drift is from 34 to 58 metres thick. Five exploration holes indicated that the gypsum bed ranged from 93% gypsum over 4.3 metres to 85% gypsum over 15.2 metres. While investigating the gypsum deposit, one cored hole, 8 kilometres north of Portage la Prairie, showed a small flow of gas from the red beds below the gypsum. An analysis of the gas indicated a helium content of 1.19%.

The gypsum beds extend southeastward to the Carman and Gretna areas. Drill holes near Carman indicate a grade estimated at 80% gypsum over a thickness of about six metres at a depth of 91 metres.

Headingley-Charleswood Area

An outlying section of the Amaranth Formation occurs in the western part of the Winnipeg area and has attracted sporadic interest over the past 60 years because of its proximity to wallboard plants in Winnipeg.

Work in the 1920s suggested the gypsum occurred as rounded masses within red beds in the Charleswood area. This was confirmed in a shaft sunk in 1930, where masses of white gypsum embedded in red shale and glacial till occurred at a depth from 6.0 to 8.8 metres, underlain by red beds. In the 1960s, drill holes near Headingley cored a section of interbedded gypsum and red shale 4.6 to 5.6 metres thick, overlying red beds as much as 12 metres thick.

The results suggest a channel-type deposit 1.6 to 3.3 kilometres wide and 18 kilometres long. The western continuity to the outcrop belt has not been encountered as yet, and may have been removed during glaciation.

Dominion City Embayment

During the Jurassic period, higher land in Manitoba and in North Dakota, just south of the International Boundary, enclosed a lagoonal extension to the ancient sea. Jurassic strata in the Dominion City Embayment, which occur 48 to 105 kilometres south and southeast from Winnipeg, include red beds, gypsum and anhydrite of the Amaranth Formation and, in places, dolomite of the overlying Reston Formation (Figure 4).

As early as 1911, exploration holes in the area intersected gypsum beds 27 kilometres east of Dominion City. Gypsum has also been reported in numerous water wells in the area.

Exploration drilling in the early 1960s by Western Gypsum Products Limited outlined a large gypsum deposit near Silver Plains, which was brought into production in 1964. The overburden consists of 32 metres of glacial lake clay and till. Rock characteristics are variable, but a section in the mine area showed an upper 4.5 metre layer of interbedded green and brown shale and gypsum, and 16.7 metres of gypsum with anhydrite and dolomite patches in a mosaic arrangement with thin interbeds of red shale and dolomite. Buff to red clay dolomite and sandstone make up the bulk of the underlying Amaranth red beds, which can be as much as 18.2 metres thick.

The Silver Plains mine yielded from 71,120 tonnes to more than 152,400 tonnes of gypsum annually, recovered by the room and pillar method. A 4.3 metre layer was removed in most places, and a second, lower 4.3 metre layer was recovered from one quadrant of the mine. The gypsum was crushed underground, transported by conveyor belt up an incline to loading bins, and trucked to a wallboard plant and two cement plants in Winnipeg. Some gypsum was shipped to wallboard plants in Saskatchewan and Alberta, and to a cement plant in Saskatchewan.

The sandstone portion of the red beds underlying the mine is an aquifer containing artesian water. Following 10 years of mining, the artesian water broke through the floor of one section of the mine, and efforts to control the flow were unsuccessful. The mine flooded in June 1975 and had to be abandoned. Western Gypsum Products drilled an area east of Red River near Aubigny in 1976 in an attempt to outline a deposit for a new mine, but as of 1986 no new developments have taken place.

Conclusion

The extent and accessibility of Manitoba's gypsum reserves ensure the continued viability of the gypsum and wallboard industries in the province. Manitoba's known reserves of gypsum are much larger than the presently exploited deposits. However, the economics of mining this low-cost, high volume material puts a premium on transportation and bulk mining methods. Because of this, future increases in gypsum production will likely be from quarries in the Amaranth area, because of the favourable transportation distance and low cost, open pit reserves.

Manitoba Energy and Mines

Manitoba Energy and Mines is continually working to increase our understanding of Manitoba's geology and its mineral resource base. Energy and Mines fieldworkers and analysts, working with their federal counterparts and private industry, have amassed a wealth of information in technical reports. More detailed information on gypsum in Manitoba can be obtained by contacting:

Exploration Services
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Winnipeg, Manitoba R3C 4E3
(204) 945-6541

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